AUBE '01

12TH INTERNATIONAL CONFERENCE ON AUTOMATIC FIRE DETECTION

March 25 - 28, 2001
National Institute Of Standards and Technology
Gaithersburg, Maryland U.S.A.

PROCEEDINGS

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Electromagnetic compatibility and radio-linked systems

Abstract

In April 2000, the new European directive R-TTE (Radio and Telecommunications Terminal Equipment) came into effect. The manufacturers are now able to use this new directive to demonstrate by themselves, their product compliance with the relevant protection criteria.

We explain this new approach by analysing the requirements which are given in the relevant ETSI standards for the security systems, which used radio-frequency links. Then we'll make the comparison between the EMC requirements for a dedicated wired system, for a radio-frequency linked system and for a system using these two kinds of communication paths.

Finally, we'll compare the new R-TTE Directive EMC requirements with security and reliability requirements given in the standard draft for alarm system using radio-frequency links (PrEN 50 131-5-3 standard draft)

Introduction

Since 1996, all the apparatus which have been placed on the European Community market, shall bear with the CE conformity marking. This marking presumed of the conformity of this device to the essential requirements of the relevant European directives. This CE marking allows, in a regulatory framework, the placing on the market, free movement and putting service in the European Community.

For electronic security systems, we can distinguish mainly, three European directives:

- The Electromagnetic Compatibility Directive (mainly: 89/336/EEC)
- The Low Voltage Directive (mainly 73/23/EEC)
- The Radio and Telecommunication Terminal Equipment Directive (1999/5/EEC)

1) Application field and essential requirements of these relevant directives

1.1) The electromagnetic compatibility directive (89/336/EEC)

The electromagnetic compatibility Directive applies to electrical and/or electronic apparatus, where apparatus means all electrical and electronic appliances together with equipment and installations containing electrical and/or electronic.

The **electromagnetic compatibility** means the ability of a device, unit or equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

There are two essential requirements for this European directive:

- The disturbance, which is generating by the apparatus does not exceed a level allowing the radio and telecommunications equipments and other apparatus to operate as intended, and
- The apparatus has an adequate level of intrinsic immunity of electromagnetic disturbance to enable it to operate as intended

1.2) The low voltage directive (73/23/EEC)

The Low Voltage Directive shall only apply if voltage between 50V and 1.000V for alternating current and/or between 75V and 1.500V for direct current is involved in the apparatus. This is the case for apparatus plugged on the main power network.

There are 11 essential requirements in this directive which can be resumed as follows:

- The manufacturers, or brand name , or trade mark should be clearly marked on the equipment or, if it is not possible, on it's packaging.
- The essential characteristics, the recognition and observance of which will ensure that electrical equipment will be used safely and in applications for which it was made, shall be marked on the equipment, or, if this is not possible, on an accompanying notice.
- The electrical equipment should be so designed and manufactured as to ensure that it can be safely and properly assembled and connected, and to ensure that protection against internal and external hazards are provided in such a way that persons and domestic animals are adequately protected against danger. These objectives should be met just as well, when the equipment is used in applications for which it was made, as in foreseeable conditions of overload.

1.3) The Radio and telecommunication terminal equipment directive(1999/5/EEC)

This directive applies to apparatus which, in this background, has to be defined as followed:

"apparatus" means any equipment that is either radio equipment or telecommunication terminal equipment or both.

"telecommunications terminal equipment" means a product enabling communication or a relevant component thereof which is intended to be connected directly or indirectly by any means whatsoever to interfaces of public telecommunications networks (that is to say, telecommunications networks used wholly or partly for the provision of publicly available telecommunications services);

"Radio equipment" means a product, or relevant component thereof, capable of communication by means of the emission and/or reception of radio waves utilising the spectrum allocated to terrestrial/space radio-communication.

The essential requirements for all the equipments which are concerned by this directive are: - to meet the requirements of the electromagnetic compatibility directive (89/336/EEC) and,

- to meet the low voltage directive (73/23/EEC), but with no low voltage limit applying.

In addition, there is another essential requirement which applies only to radio equipment, subscribing that radio equipment shall be so constructed that it effectively uses the spectrum allocated to terrestrial/space radio communication and orbital resources so as to avoid harmful interference.

2) The harmonized standards to meet these three European directives:

The essential requirements to meet European directives are described in harmonized standards, which contain technical specifications and which are adopted by a recognised standards body under a mandate from the commission.

There are many harmonised standards for these European directives in the field of electronic security systems. If we consider the most complete case (in the sense of these three directives) for electronic security equipment, this latter may be made of :

- An enclosure,
- Alternative current inputs and/or outputs (generally: the main power input),
- Direct current inputs and/or outputs,
- A functional earth port,
- Signal and/or control inputs and/or outputs,
- Connections to telecommunications networks,
- Radio-frequency transmitting subsets, and
- Radio-frequency receiving subsets.

An illustration of this kind of equipment us given in illustration 1.

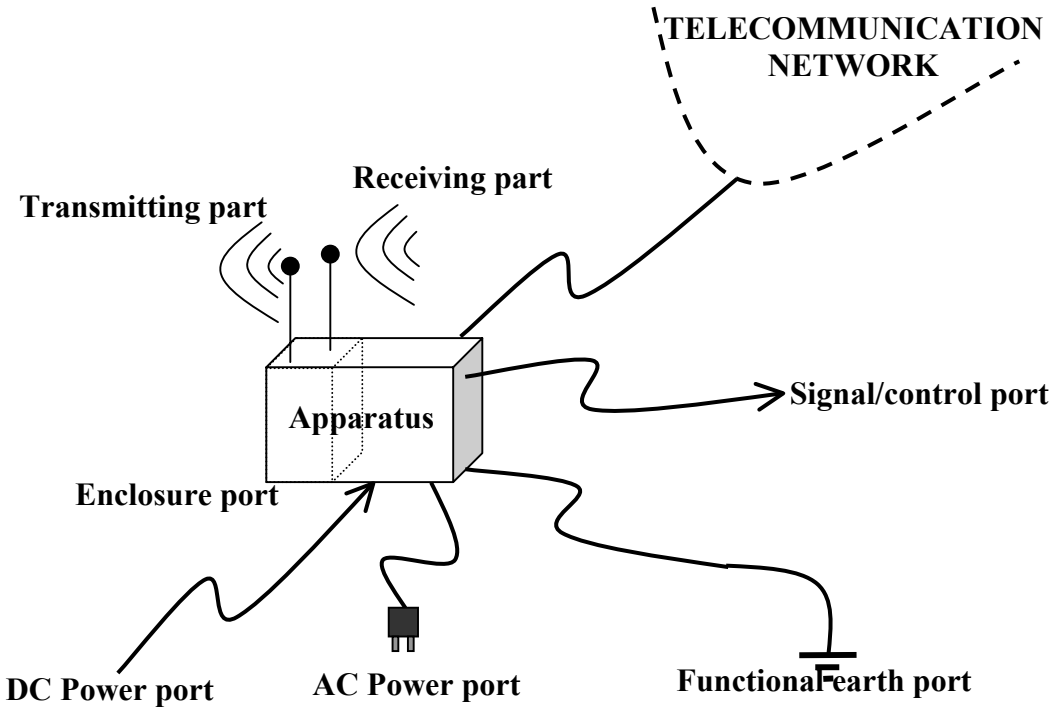

Illustration n°1: most complete case of an electronic security equipment

At the opposite, the most simple case for an electronic security equipment is an equipment without any external connection and powered with low voltage batteries (less than 75 V), for example: a domestic smoke detector (shown in illustration n°2).

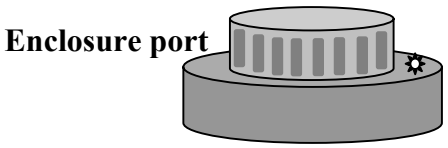

Illustration n°2: most simple case of an electronic security equipment

At first, we can list the relevant standards which have to be applied to meet the three European directives for electronic security equipments:

2.1) For the Low voltage directive:

DIRECTIVE	KIND OF EQUIPMENT	SUBSET	HARMONISED STANDARDS	Date of publication
LOW VOLTAGE DIRECTIVE (73/23/EEC)	Any radio equipment	ALL	EN 60 950 +Amendments A1, A2, A3 & A4	January 1993
	Any telecommunication terminal equipment	ALL		
	Other equipments involving Voltage in the following ranges: between 50 and 1.000V for alternating current and/or between 75 and 1.500V for direct current	ALL		
	Any other equipment which is not part of those aforementioned	Low voltage directive does not apply		

Table n°1: harmonised standards to meet the essential requirements of the low voltage directive in the case of an electronic security equipment

2.2) For the Electromagnetic compatibility directive:

DIRECTIVE	KIND OF EQUIPMENT	SUBSET	HARMONISED STANDARDS	DATE OF PUBLICATTION
EMC DIRECTIVE (89/336/EEC) EMISSION ASPECTS	Any radio equipment	ALL	no harmonised standard at this day	
	Any telecommunication terminal equipment	ALL	EN 50 081-1	1992
	Any other equipment	ALL	EN 50 081-1	1992

Table n°2: harmonised standards to meet the essential requirements for the emission aspects of the electromagnetic compatibility directive in the case of an electronic security equipment

DIRECTIVE	KIND OF EQUIPMENT	SUBSET	HARMONISED STANDARDS	DATE OF PUBLICATTION
EMC DIRECTIVE (89/336/EEC) IMMUNITY ASPECTS	Any radio equipment	ALL	no harmonised standard at this day	
	Any telecommunication terminal equipment	ALL	EN 50 130-4	1995
	Any other equipment	ALL	EN 50 130-4	1995

Table n°3: harmonised standards to meet the essential requirements for the immunity aspects of the electromagnetic compatibility directive in the case of an electronic security equipment

2.3) The Radio and telecommunication terminal equipment directive

In the case of a radio equipment, the harmonised standards are not yet defined. But we already know that they will be defined in function of the transmitted power.

For the communication inside an alarm system, only short range devices are involved in the system and in this case we have good presumptions to say that the harmonised standards will be: - **ETS 300 220** series for the requirements related to the spectrum utilisation

And - **ETS 300 683** standard for the EMC aspects for the short range devices operating on frequencies between 9 kHz and 25 GHz.

For the radio-telecommunication equipments (like GSM, DCS 1800, UMTS, TETRA, etc…) the standards are not yet harmonised in all over Europe, and in this case, national regulations may still be in force or, it may happen that there are restrictions on the use of the equipment in certain European countries.

For that reason, at this date, we can see different kinds of temporary CE marking as shown in illustration n°3.

Illustration n°3: temporary CE marking in the case of a radio equipment

These temporary CE marking may be split up into three parts:

- At first, the CE marking in itself ( ), as defined in the main European directive
- then: the number of the notified body ( ) which has intervened in the conformity evaluation according to European standards which are not yet harmonised
- and, at least: the warning sign ( ), which means that the frequency range which is used is not yet harmonised in Europe

In conclusion, for a radio device we have four different CE marking:

At this date, we have:

: in the case of frequency range which is used is already harmonised in Europe and standards which has been used to assess the conformity to the R-TTE directive are already harmonised

: in the case of frequency range which is used is not yet harmonised in Europe and standards which has been used to assess the conformity to the R-TTE directive are already harmonised

CE N° XXXX: in the case of frequency range which is used is already harmonised in Europe and standards which has been used to assess the conformity to the R-TTE directive are not yet harmonised

CE N° XXXX(!) in the case of frequency range which is used is not yet harmonised in Europe and standards which has been used to assess the conformity to the R-TTE directive are not yet harmonised

When the relevant frequency ranges and standards to assess the conformity to the essential requirements of the R-TTE directive will be harmonised in Europe, it will only remain the simple marking. CE

2.3.1) Requirements to meet the EMC directive and the EMC aspects of the R-TTE directive in a case of a short range device:

In the field of electronic security systems, the short range devices are mainly the equipments which make up the radio-linked alarm systems such as: Radio-frequency linked intrusion and/or fire alarm systems, and the social alarm systems. There are two frequency bands which are allowed in Europe:

- 433,05 MHz - 434,79 MHz and
- 868 MHz – 870 MHz

These two frequency ranges are allocated for short range devices, which have an allowed maximum radiated power lying between 10 mW and 25 mW for the application of alarm systems.

For this kind of device, there are some restrictions for the use of the frequencies in certain European countries, that means that there is no harmonisation for the frequency bands. But, we know that the relevant standard which provides the requirements for a

correct use of these frequency bands, is **ETS 300 220-1 [Radio Equipment and Systems (RES), Short range devices Technical characteristics and test method for radio equipment to be used in the 25 MHz to 1.000 MHz frequency range with power level ranging up to 500 mW; Part 1: Requirements related to spectrum utilisation]**. This latter mainly defines the maximum power level in function of the frequencies inside and outside the used frequency channel.

For the EMC requirements, the relevant European standard is **ETS 300 683 [Radio Equipment and Systems (RES) ElectroMagnetic Compatibility (EMC) standard for Short Range Devices (SRD) operating on frequencies between 9 kHz and 25 GHz]**.
This standard defines four kinds of EMC requirements:

- The Continuous phenomena applied to Receivers (CR)
- The Continuous phenomena applied to Transmitters (CT)
- The Transient phenomena applied to Receivers (TR)
- The Transient phenomena applied to Transmitters (TT)

It defines also 3 classes of equipment (1,2 & 3) in function of the impact on persons and/or goods in case the equipment does not operate above the specified minimum performance level under EMC stress. For the radio-frequency linked alarm systems, the corresponding class of equipment is the class 1 (Alarms application; Domestic security). And at least, the standard defines 3 equipment types (I, II &III) in function of the technical nature of the primary function of the equipment, for the radio-frequency linked alarm system, the appropriate equipment type is I [transfer of messages (digital or analogue signals)].

The tests which are required to meet the ETS 300 683 for the radio linked alarm systems are described in the table n°4.

For the Radio-frequency electromagnetic field (80 MHz – 1.000 MHz), the standard specifies an exclusion band for the receiving equipments in which this test does not

need to be performed. For the frequency bands which are allocated for the alarm systems, this exclusion band is defined as follows:
The lower frequency of the exclusion band is the lower frequency of the intended operating frequency band minus 5% of the operating frequency and the upper frequency of the exclusion band is the upper frequency of the intended operating band plus 5% of the operating frequency.

The other tests have to be performed with the same procedure as for the none radio equipments.

The performance criteria are defined in function of the kind of test (continuous or transient) and the class of equipment (for the alarm systems: class 1). For each test there are performance criteria during the test and after the test.

Phenomena	Application	Equipment test requirement		Reference document
		Fixed equipments	Remote control	
EMISSION REQUIREMENTS				
Emission measurements	Enclosure	Applicable to ancillary equipments	Applicable to ancillary equipments	**EN 55 022**
	DC power in/out	Applicable	Not applicable	**EN 55 022 CISPR 16-1**
	AC mains	Applicable	Not applicable	**EN 55 022**
IMMUNITY REQUIREMENTS				
RF electromagnetic field (80 MHz - 1.000 MHz)	Enclosure	Applicable	Applicable	**EN 61000-4-3**
Electrostatic discharge	Enclosure	Applicable	Applicable	**EN 61000-4-2**
Fast transients common mode	Signal and control ports, DC and AC power ports	Applicable	Not applicable	**EN 61000-4-4**
RF common mode (current clamp injection) 0,15 - 80 MHz	Signal and control ports, DC and AC power ports	Not applicable	Not applicable	**EN 61000-4-6**
Transients and surges	DC power input ports	Applicable	Not applicable	**ISO 7637 Parts 1 & 2**
Voltage dips and interruptions	AC mains power input ports	Applicable	Not applicable	**EN 61000-4-11**
Surges, common and differential mode	AC mains power input ports	Applicable	Not applicable	**EN 61000-4-5**

Table n°4: EMC tests for short range devices according to ETS 300 683

3) The European standard draft for radio linked alarm systems:

For the radio-frequency linked alarm systems there are, on top of the essential requirements to meet the three relevant European directives and of the requirements related to spectrum utilisation, an European product standard draft in preparation at the CENELEC/TC79 level: **Pr EN 50 131-5-3 (Alarm systems – Requirements for interconnections equipment using radio frequency techniques)**.

This standard specifies reliability and security requirements for the radio frequency link in the field of alarm systems. It specifies four grades (1 to 4) based on different level of reliability and security, for which the higher level is obtained for the grade 4.

For the reliability aspects this draft proposes requirements about:

- the throughput rate, which requires that a minimum number of alarm messages that generate an alarm at the receiving equipment shall be 999 out of 1.000 for grades 1 & 2 and 9.999 out of 10.000 for grades 3 & 4.
- Immunity to unintentional message and component substitution
- Immunity to attenuation, in order to prevent any modification in the surround which may affect the RF link budget.
- Immunity to outband interferences
- Immunity to inband interferences (saturation)
- RF links monitoring

For the security aspects, there are mainly requirements about tampering:

- Immunity to intentional component substitution (for grades 3 & 4)
- Immunity to intentional message substitution (probability to discover an identification code in less than one hour (less than 5% for grades 1 & 2, less than 0,5% for grade 3 and less than 0,05% for grade 4)
- Detection of interference (saturation of the receiver with an intentional signal at the same frequency as the operating frequency of the system)

Among all the requirements provided by the Pr EN 50 131-5-3, there are only two requirements which are comparable to those provided by the European directives.

There are about:

- the RF electromagnetic field immunity test required by the ETS 300 683 and,
- the outband and the inband immunity test required by the Pr EN 50 131-5-3

If we compare these two tests, we can see that they are complementary. We have seen before that for the RF electromagnetic immunity test of the ETS 30 683, there are an exclusion band, inside which the test is not performed. In Pr EN 50 131-5-3, these tests have to be performed at the limit frequencies and/or inside this exclusion band in function of the grade as described in the table 5. The signal which is applied is different from the two standards, such as for the product standard (Pr En 50 131-5-3), the interference signal is very closed to the original one (at the difference of the frequency) and the performance criteria in the case of the product standard ask for 80% of good transmissions in the presence of the interference signal.

	F_1	F_O	F_2
GRADE 1	**3 V/m**	**L_O - 12 dB**	**3 V/m**
GRADE 2	**3 V/m**	**L_O - 12 dB**	**3 V/m**
GRADE 3	**10 V/m**	**10 V/m**	**10 V/m**
GRADE 4	**10 V/m**	**10 V/m**	**10 V/m**

Table n°5: Outband & inband immunity test according to PrEN 50 131-5-3

In the table 5; - **F_1** means the lower frequency limit of the exclusion band
- **F_O** means the operating frequency of the considered equipment
- **F_2** means the higher frequency limit of the exclusion band
- **L_0** means the level of the operating signal

These requirements show that higher is the grade, higher is the reliability level for the equipment which meets the PrEN 50 131-5-3 standard.

Conclusion

So, we can conclude that there is a good complementarity between the essential requirements in the sense of CE marking and those from the product standard draft for the radio frequency links used in the wire free alarm systems.

Indeed the main aim of the essential requirements of the European directives is to assure that the equipment can be used safely and that this equipment would not cause any trouble to the other devices which are in its environment, whereas the aim of the CENELEC product standards is to ensure that the devices have a good level of reliability, security and tamper resistance.